

# **MARS GLOBAL SURVEYOR Ka-BAND DATA ANALYSIS**

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The capability to communicate across interplanetary distances has increased by several orders of magnitude since the advent of space exploration some 40 years ago. Since 1959, there has been a 8.8 fold increase in the radio frequency; from L-band (0.96 GHz) to X-band (8.4 GHz) which became in 1977 the primary deep-space telecommunications downlink frequency. A shift to Ka-Band (32 GHz) is projected to add another 6 dB. In recent years, Ka-band demonstration experiments have been flown on several spacecraft (Mars Observer, Surfsat-1, Mars Global Surveyor, and DS1) for the purpose of demonstrating this link advantage. In addition, by using the higher Ka-band frequency, charged particle effects on the frequency data type are significantly reduced, which is advantageous for Radio Science gravitational wave experiments such as that being flown on the Cassini spacecraft.

The Mars Global Surveyor (MGS) spacecraft, launched on November 7, 1996, carries an experimental space-to-ground telecommunications link at Ka-band (32 GHz) along with the primary X-band (8.4 GHz) downlink. The signals are simultaneously transmitted from a 1.5-m diameter parabolic antenna on MGS and received by a beam-waveguide (BWG) R&D 34-meter antenna located in NASA's Goldstone Deep Space Network (DSN) complex near Barstow, California. The two signals have been regularly tracked between December 1996 and December 1998.

Results will be presented which demonstrate the projected advantage of Ka-band over X-band inferred from the signal level data acquired at the Goldstone tracking site (after correcting for Ka-band equipment deficiencies on the spacecraft and correcting for projected ground station Low Noise Amplifier performances). Analysis of X-band ( $f_x$ ) and Ka-band ( $f_{Ka}$ ) frequency and difference frequency ( $f_x - f_{Ka}/3.8$ ) data from the link experiment will also be presented. The link experiment measured frequency estimates and residuals which agree between bands and have statistics which are consistent with those of expected noise sources. Results of data acquired during the Solar Conjunction period of May 1998 in order to study propagation effects through the solar plasma will also be presented.

Lessons learned from the MGS Ka-band link experiment included the importance of maintaining accurate antenna pointing at both the ground station (where a monopulse receiver package was used) and the spacecraft (where adequate pointing for Ka-band was maintained primarily during the cruise phase of the mission).